Evaluating Urban Resilience under Conflict

A topological approach

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Keywords: urban system, adaptative cycle, entrophy, evolvability, the Bijlmermeer neighborhood.

Introduction

The aim of this project is to decipher urban structures and morphologies that are capable of evolving in order to conserve their behavior as the identity of the system. Consequently, the study of their resilience focuses on the analysis of urban structures that have suffered damage as a result of an intense conflict. However, these damaged structures exhibit emergent variables that can be clearly registered, and therefore clearly evaluated. For this purpose, the concept of resilience is related to the evolvability –the capacity of a system for adaptive evolution– of urban structures under social or armed conflict.

The concept of resilience used in this research derives from an analogy previously developed in the field of ecology. The background literature for this study comes from the early 2000s, when the term resilience was applied to the complex system theory and has since been extensively developed in the field of ecological disasters (Holland, 1992; Holling, 2001; Holling & Gunderson, 2002; Gotts, 2007; Parrot & Lange, 2013).

In order to analyze the resilience of a specific urban structure, the space is observed from a topological perspective. The urban system as a network is examined to identify destroyed, preserved and newly produced relations.

As a result of identifying the topological processes, the alterations in the relations between different urban elements are evaluated, as well as the disturbances that have been absorbed by the system, thanks to its resilience. In fact, the concept of resilience may be defined as "…the magnitude of disturbance that can be absorbed before the system changes its structure by changing the variables and processes that control behaviour" (Gunderson & Holling, 2002). Hence, both the structures that remain and those that disappear after the alteration of the adaptive cycle caused by the conflict are analyzed and evaluated.

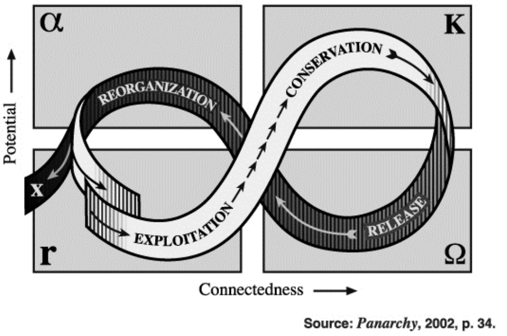


Figure 1: The adaptive cycle. Source: Gunderson & Holling, 2002.

Although the method used has been applied to the analysis of three urban areas, in this article only one structure under conflict is presented. This case study concentrates on the development of the Bijlmermeer neighborhood, in the southeast of Amsterdam, in the Netherlands, from its construction in the 60s and 70s till its partial demolition from 1992 to 2012, caused by the high rate of crime reported in the area. However, in the future, the research will be applied to other selected case studies to improve the method and to further the concepts of evolvability and resilience.

All selected urban structures are located in a specific space and time. Moreover, each urban area chosen has been under a different type of conflict. As mentioned previously, this type of situation is characterized by its high level of uncertainty that produces many urban alterations. These may be clearly registered, and used as a laboratory of urban phenomena.

The morphology and the physical space are analyzed cartographically in discrete time, and they represent several states. As a result, the successive physical states become visible and physical alterations in the morphology may be observed. These cartographical representations are used to develop a topological model of each discrete state. Due to the focus on the relational field, the models of discrete states reflect the destroyed, preserved or produced relations. In short, the space is transformed into a system of networks, where the alterations of the relations during a specific time *t* are evaluated.

First approach: the urban system

The methodological parallelism between the analysis of natural systems and the analysis of urban systems is a product of their own essence. If natural systems are considered complex systems, urban systems may be equally stated (Ruiz, 2001). Consequently, the applied methodologies in ecology seem to be valid for the study of cities, at least when approaches to the city are based on the systems theory.

A system is obtained dividing the Universe into two halves. The first one is the part we are interested in, *the system*. The second one is the rest of the Universe, named as *the environment*. The first qualification of a system regarding its *thermodynamic* *exchange* with the environment determines an initial classification. In this respect, an *isolated system* is a system not capable of exchanging either matter or energy with its environment. A *closed system* is a system which exchanges energy with its environment, but not matter. Finally, an *open system* is a system available to exchange matter and energy with its environment (Luhmann, 1996).

From the perspective of the systems theory, an urban area may be labeled as an *open complex system*, since it exchanges both matter and energy with its environment. According to the second law of thermodynamics, an isolated system tends towards equilibrium, where it acquires a state of maximum entropy, in which the increase in entropy is equal zero. However, an open system, in contrast to the isolated system, may produce negative entropy –or negentropy–, as it can export part of its entropy to the environment. To define this complex state, the essence of the city needs to be included in the definition, since it is not only conformed by physical systems but also by social or communicative systems (Ruiz, 2001). Hence, to define the city as an open system is not enough. The city is an *open complex urban system* made up of subsystems which exchange matter, energy and information with its environment.

In such way, the city is capable of producing negative entropy. The Boltzmann entropy gives the system an idea of organization based on the fact that the order inside the system increases thanks to a decrease in its entropy. In isolated systems, entropy can only increase to a limit, the equilibrium, which produces an irreversible process. In contrast, in an open system, the entropy can increase or decrease depending on the exchange with the environment. If the stimulus of the environment –the variations on the initial conditions of the system– allow the system to increase its order, there is a reduction of entropy inside the system. However, if the exchange between the system and the environment provokes an increase in disorder, there is a rise in entropy in the system. These processes are always irreversible, in fact, the more entropy –and disorder– the system gains, the less possible the return to an ordered state is. Many systems, such as urban systems, have the capacity of organizing and disorganizing themselves, the first example being living systems. Yet the organization from the disorder requires an enormous amount of energy at the expense of the environment (Wagensberg, 1985).

System under conflict

Not always an individual or an entity can resist the uncertainty of the world (Wagensberg, 2004). Nevertheless, the question to consider would be how urban systems resist the high level of uncertainty that the environment provokes on occasion. On the assumption that the exchange of entropy with the environment commences to be positive, entropy inside the urban system increases and uncertainty compels. At that point the urban system, as well as any other system, must be adaptive in order to remain an individual or an entity.

As mentioned above, the complex city is formed by physical, energy and social systems. The inert matter tends to preserve itself, the living matter tends to continue living and the social agent tends to continue learning (Wagensberg, 2004). On account of this, the complex and resilient city is a system –an individual or an entity– that requires to be adaptive to keep on existing. “In the world of the inert matter, to remain means to continue staying (stability); in the world of living matter, to remain means to continue alive (adaptability) and in the cultured world, to remain means to continue learning (creativity)" (Wagensberg, 2004, pp. 65, translated by the author).

The system remains within a state of stability. Urban systems, as open systems, cannot exist in a state of equilibrium, but they can exist in a state of stability. Under stability, the fluctuations of systems are of low intensity and variations run from one probable state to another more probable one (Wagensberg, 1985). However, when the fluctuations cease to return to the stable state, the change occurs and many new possible states appear, although randomness[1] selects only one. Change alters the structures, but the complex system is not elastic –it cannot be deformed reversibly– since processes of complexity are irreversible. Yet the complex system is capable of being resilient and of evolving in order to adapt.

In the Bijlmermeer, the chain of events led to an increase in the system's entropy, produced by the high uncertainty provoked by the environment. This rise in entropy became a threat for the identity of the Bijlmermeer's urban structure, which abandoned its stability to access a change that would alter a large number of its substructures. Therefore, and concerning the Bijlmermeer's evolution, two main features need to be clarified: firstly, its urban structure, and secondly, the urban conflict associated in particular with the increase in crime that befell the neighborhood after its construction.

The Bijlmermeer, the loss of innocence

The Biljmermeer is a neighborhood in the peripheral area of southeast Amsterdam, planned by the architect and urban planner Siegfried Nassuth in the 1960s. Previously to its construction, the building area was located in a vast polder extension (5 km^2) newly dried and not urbanely connected with the city center. The Bijlmermeer was a radical implementation of the postulates held by the CIAM in 1933 and developed in the Athens Charter. Indeed, it was just a modern neighborhood based on the utopian 'functional town', in which living, working and traffic were separated. In the case of the Bijlmermeer development, 90% of the constructed environment was planned as a high-rise low-density development formed by a large extension of eleven-story honeycomb buildings (Van de Klundert, 2012).

Once the construction started in 1966, huge concrete structures appeared in the old rural area, but it was not until 1975 that the planned dwellings were completed, although the entire public transport system and the main planned facilities were not. The honeycomb buildings followed the strict rules of the plan presented by Nassuth. The first two floors were projected as storage and the traffic system was completely separated: the metro system at 10 meters above the ground, the main roads and car parks at 3.7 meters (constructed as dikes), with only pedestrians and bicycles accessing the ground level, where all the front doors were located. The car parks were connected to the high-rise buildings through long 'dry' passageways, planned as inner pedestrian streets, on the first level (3.7m), only connected to the ground level through staircases and elevators.

[1] Randomness is the lack of pattern or predictability in events.

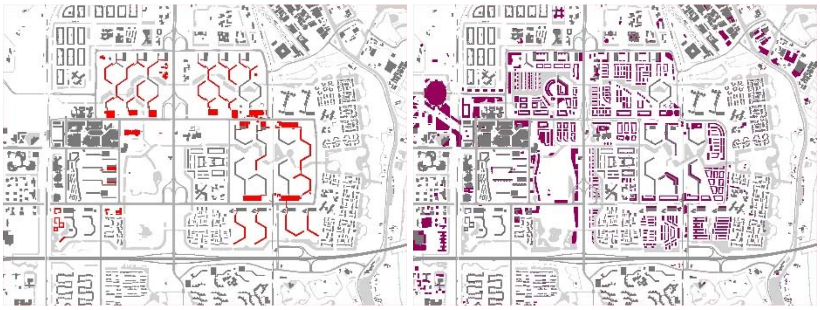
Figure 2: In the center honeycomb buildings, on the left the elevated metro line, 1973. Source: www.beeldbank.amsterdam.nl

The Bijlmermeer was expected to be a new residential area, where middle class families raised their children. Yet reality defeated this idealistic city. The rental market led to an unexpected social environment, more single people who normally would not have been accepted could rent a flat, and the occupancy was lower than envisioned. In the 1980s there was a 25% vacancy rate, which was not affordable by the housing market (Van de Klundert, 2012). Safety and crime were always an issue in the Bijlmermeer, although the image projected was worse than the crimes reported –the main reported problems were always related with drug dealing and consume.

The conflict in the Bijlmermeer was a problem caused by different factors, which centered around vandalism, lack of safety, unfinished public services, degradation and vacancy in a single space. The planned collective spaces were abandoned or not constructed and they lost their projected functions (Helleman & Wassenberg, 2004). The reality turned into a completely different image in comparison with the idealistic city envisioned by a modern architect.

Figure3: Car parks in the 1980s. Source: http://pieterboersmaphotography.com

The case of the Bijlmermeer neighborhood was paradigmatic since the response to the whole problem associated with crime and degradation of its structure was, from the perspective of urban planning, absolutely radical. Despite the different approaches to a possible remodeling of the neighborhood, some of them carried out by well-known architects such as Oscar Newman and Rem Koolhas in the 1980s, finally, in 1993 an agreement between the Municipality of Amsterdam, the Centraal Fonds Volkshuisvesting, private investors and New Amsterdam housing corporation was signed to allow the renewal and demolition of at least a quarter of the high-rise buildings of the Bijlmermeer (Grunhagen 1994).



Map 1 and 2: On the left, the Bijlmermeeer neighborhood in 1992, in red the buildings to be demolished; on the right, the interrupted plan for the Bijlmermeer 1992-2012. Source: Van de Klundert, 2012.

The decision to select the Bijlmermeer as one of the case studies was neither without justification nor accidental, since high-rise developments have a controversial background in the history of urbanism. Pruitt-Igoe[2] could be considered as a previous case which shows the difficulty that high-rise housing developments have trying to overcome unexpected conditions. Several authors have argued that the spatial configuration is a key factor for the progress of conflict and crime (Coleman, 1985; Jacobs, 1961; Newman, 1972). Under their perspective, the analysis of these conditions tend to be focused on the gain of security. However, another approach may confer new findings, an approach that goes beyond the design of secure space, and still focuses on the capacity of evolution existing in the urban area.

The urban structure of the Bijlmermeer would have been able to resist the high rates of crime, the vacancy rates, or the unfinished public infrastructure, but it did not. An adequate question might be whether the demolition of the structure would have been a reality if the urban morphology had been different. The intention is not to simulate other possible realities, but to compare the topological reality of the Bijlmermeer before and after the remodeling project. In the Bijlmermeer, a vast modification of the

[2] Pruitt-Igoe was a public housing development located in the U.S. city of St. Louis, completed in 1954 and composed by thirty-three eleven-story buildings. It was completely demolished between 1972 and 1976, after being internationally known for its poverty, crime and segregation.

physical space was carried out, as well as a modification in the topological space and the relational field and this should be taken into account.
The morphological models (see figure 4) formidably present the new structure in the Bijlmermeer, which was modified using a high energy, economic and also social cost. Its urban morphology has been substituted by new buildings as well as a new net of streets, most of them planned in a neighborhood scale (Blair & Hulsbergen, 1993). Beyond the morphological alterations –the change in the physical space–, there is an alteration in the topological space which seems to be equal or more radical. As Alexander (1961) and Salat (2012) argued, some cities seem to be trees, while others seem to be leaves. The twigs of a tree are not interconnected, since it is not possible to access from one to another without descending to the branches of higher rank, whereas the veins of a leaf are extremely connected in the intermediate scale. The connectivity of a city can be measured through the topological analysis of the system, which is a process of abstraction from the models in figure 4.

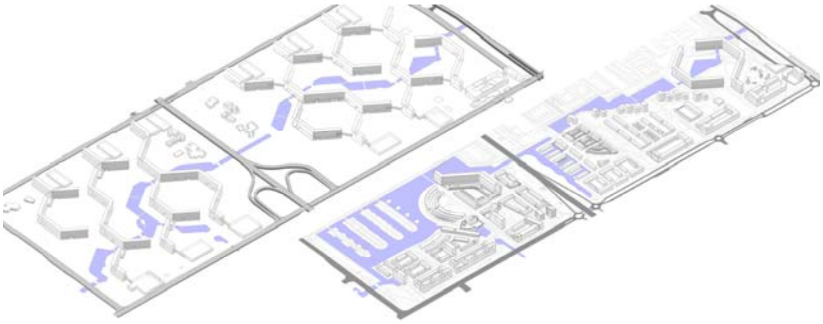


Figure 4: A morphological model of a fragment of the Bijlmermeer neighborhood in 1992 (left) and in 2012 (right). Source: the authors.

In the case of the Bijlmermeer, the original structure not only followed a simple functional scheme, but it was also developed as an unmixed and mere morphological and structural system. Both the connectivity of fluxes (pedestrians, bicycles, private vehicle and public transport) and the invariability of the structures were features that impeded the natural adaptability of historical urban systems. The modern structure, unlike the historical urban tissue, had difficulty adapting, since the structures were overly rigidly conceived (Salat, 2012).
Beyond the spatial quality of the building typologies of the Bijlmermeer, the chain of events seems to indicate that one of the intrinsic causes that produced both the demolition of more than a half of the neighborhood and the entire change in the structure was its incapacity for evolution. The external perturbations remained; crime and vacancy persisted despite the effort made in the 1980s to overcome them; the urban structure had its problems evolving and adapting in front of the demand of the environment. It seemed to be a structure with low resilience, and structure with few options and little capacity for evolution. In an analogy with a living being, the system could not survive since it was not capable of adapting and the system degenerated

little by little. The fluctuations created conditions of high uncertainty that provoked the dissipation of the initial structure.

Figure 5: The new morphology of the Bijlmermeer, 2014. Source: http://falkepisano.info/luca-frei-lc-pavilion.

The structure of the Bijlmermeer followed a simple scheme which was also extremely dependent on its own structure. Any disconnection, any alteration in the system could provoke a short circuit. The simplification of the topological model led to an oversensitive system facing external perturbations. The structural interdependence complicates the adaptability, since the gradual changes in the intermediate scale were not possible. Unlike in the historical city, in which small plots and the sole ownership allowed for the gradual evolution of the structure, in urban areas such as the Bijlmermeer, the scale of the building typology barely allow an evolution in the structure, although variations in the inner typology are possible –for instance the increase in access to buildings. This scarcity in the evolvability complicates the adaptive cycle (see figure 1), which represents "the adaptive capacity; that is, the resilience of the system, a measure of its vulnerability to unexpected or unpredictable shocks. This property can be thought of as the opposite of the vulnerability of the system" (Holling, 2001, pp. 394). Regarding this definition, the system of the Bijlmermeer seemed to be a vulnerable system in front of change, dissimilar to "the inherent potential of a system that is available for change, since that potential determines the range of future options possible. This property can be thought of, loosely, as the "wealth" of a system" (Holling, 2001, pp. 394).

Acknowledgments

This article is part of a four-year PhD research carried out between the Department of Urban and Regional Planning of the Polytechnic University of Catalonia and the Department of Urban and Regional Planning of the Polytechnic University of Madrid. The funds for this PhD research named 'The Urbanism of Security in front of Urban Complexity' come from a grant obtained from the Spanish Ministry of Education.

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